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## Student Activity 3: Going to Great Depths

**Overview:** Students investigate the relationship between the height of water in a cylinder and the number of bolts that have been added to the cylinder.

**Objective:** **Algebra I TEKS**  
(b.1.B) The student gathers and records data, or uses data sets, to determine functional (systematic) relationships between quantities.  
(b.1.E) The student interprets and makes inferences from functional relationships.  
(c.1.A) The student determines whether or not given situations can be represented by linear functions.  
(c.1.C) The student translates among and uses algebraic, tabular, graphical, or verbal descriptions of linear functions.  
(c.2.B) The student interprets the meaning of slope and intercepts in situations using data, symbolic representations, or graphs.  
(b.2.D) In solving problems, the student collects and organizes data, makes and interprets scatter plots and models, predicts, and makes decisions and critical judgments.

**Terms:** rate, slope

**Materials:** each group needs a cylinder (obtain from a science class, use a pharmacy medication bottle that is cylindrical, or use a cylindrical flat-bottomed drinking glass), uniform objects that will fit in the cylinder and sink (golf balls, marbles, centimeter cubes), water, metric ruler, graphing calculators

**Procedures:** Students should be seated at tables in groups of 3 – 4.

Note: for the sample data below, we used a cylinder and 4 golf balls. You can also use marbles but instead of adding one at a time, add 5 marbles at a time. You want the displacement to be enough to be able to measure easily. If you use 5 marbles each time, adjust the questions accordingly.

### Activity: Going to Great Depths

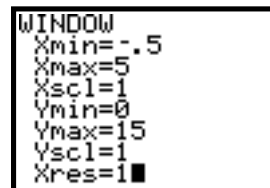
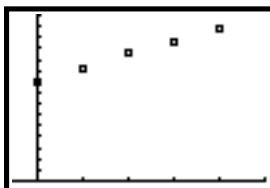
Briefly describe and/or demonstrate the experiment. Make sure students measure the water level before adding any objects.

1. Stress how important it is for students to predict the results of the experiment **before** they perform the experiment. Encourage students to think about and anticipate the results of the experiment before they begin collecting data.

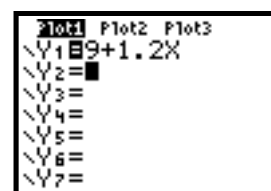
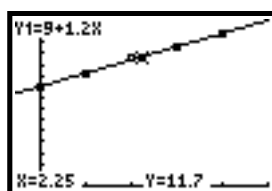
2. *Sample data:*

Number of Objects	Height (cm)
0	9
1	10.2
2	11.5
3	12.7
4	13.9

3. *Sample data:*

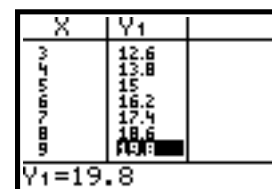
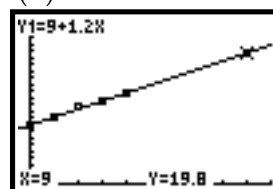
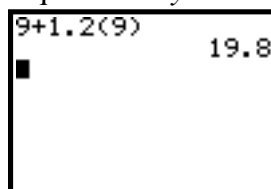


4. For our *sample data*, an estimated rate of change is 1.2 centimeters per object.
5. For our *sample data*, the y-intercept is the original water level, 9 cm.
6. For our *sample data*, a trend line is  $y = 9 + 1.2x$ .



7.

8. The units of slope are centimeters per object.
9. The real-world meaning of the y-intercept is that for zero objects the water level is the original level before there were any objects added.
10. The equation is  $y = 9 + 1.2(9)$ . Some solution methods:



11. For our *sample data*, the highest water level recorded was 13.9 centimeters so we need to find how many objects would cause the water to rise to  $13.9 + 6 = 19.9$  cm. Solve:  $9 + 1.2x = 19.9$ .  
Some solution methods:

Table:

X	Y1	Y2
4	13.8	19.9
5	15	19.9
6	16.2	19.9
7	17.4	19.9
8	18.6	19.9
9	19.8	19.9
10	21	19.9

X=9

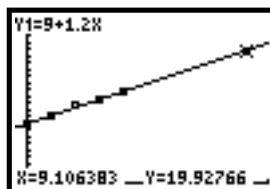
X	Y1	Y2
8	19.8	19.9
8.1	19.92	19.9
8.2	20.04	19.9
8.3	20.16	19.9
8.4	20.28	19.9
8.5	20.4	19.9
8.6	20.52	19.9

X=9.1

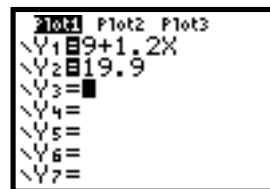
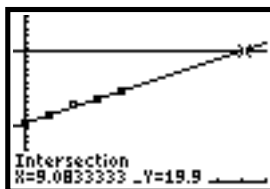
X	Y1	Y2
9.08	19.896	19.9
9.09	19.908	19.9
9.1	19.92	19.9
9.11	19.932	19.9
9.12	19.944	19.9
9.13	19.956	19.9
9.14	19.968	19.9

X=9.08

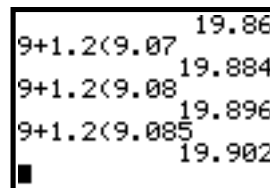
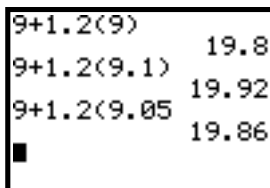
Trace:



Trace to the Intersection point.



Guess and check.



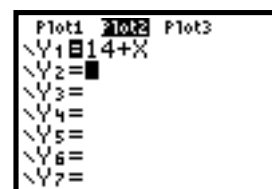
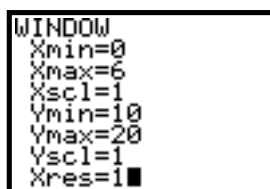
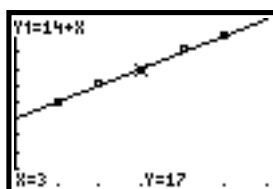
Solve algebraically, if you are at a place in your curriculum where it makes sense for students to do so:

$$\begin{aligned}
 9 + 1.2x &= 19.9 \\
 9 + 1.2x - 9 &= 19.9 - 9 \\
 \left(\frac{1}{1.2}\right)1.2x &= 10.9\left(\frac{1}{1.2}\right) \\
 x &= 9.08\overline{3}
 \end{aligned}$$

12. The more objects placed in the cylinder, the higher the level of the water.
13. The rate of change would be higher because larger objects would displace more water. Therefore the line would be steeper, have a higher slope.
14. If you added the same amount of water, the original water level would be higher. Therefore the line would shift up. Also, while the objects would still displace the same amount of water, this amount of water displaced in a smaller container would make the rate of change increase. Therefore the slope of the line would be steeper.

### Answers to Sample Assessment

1.



2.

Using a table.

X	Y <sub>1</sub>	
6	20	
7	21	
8	22	
9	23	
10	24	
11	25	
12	26	
Y <sub>1</sub> =24		

3.  $x \approx 31$ . Students answers should be close, depending on their trend lines.Using a table, in  
2 ways

X	Y <sub>1</sub>	
26	40	
27	41	
28	42	
29	43	
30	44	
31	45	
32	46	
X=31		

X	Y <sub>1</sub>	Y <sub>2</sub>
26	40	45
27	41	45
28	42	45
29	43	45
30	44	45
31	45	45
32	46	45
X=31		

**Summary:**

By collecting data and finding a trend line, students investigate the relationship between the height of water in a cylinder and the number of uniform objects added to the cylinder. Students use real data to further their conceptualization of the linear function.